5. Total Maximum Daily Load(s)

A TMDL prescribes an upper limit on discharge of a pollutant from all sources so as to assure water quality standards are met. It further allocates this load capacity (LC) among the various sources of the pollutant. Pollutant sources fall into two broad classes: point sources, each of which receives a wasteload allocation (WLA); and nonpoint sources, each of which receives a load allocation (LA). Natural background (NB), when present, is considered part of the LA, but is often broken out on its own because it represents a part of the load not subject to control. Because of uncertainties regarding quantification of loads and the relation of specific loads to attainment of water quality standards, the rules regarding TMDLs (Water quality planning and management, 40 CFR Part 130) require a margin of safety (MOS) be a part of the TMDL.

Practically, the margin of safety is a reduction in the load capacity that is available for allocation to pollutant sources. The natural background load is also effectively a reduction in the load capacity available for allocation to human made pollutant sources. This can be summarized symbolically as the equation: LC = MOS + NB + LA + WLA = TMDL. The equation is written in this order because it represents the logical order in which a loading analysis is conducted. First the load capacity is determined. Then the load capacity is broken down into its components: the necessary margin of safety is determined and subtracted; then natural background, if relevant, is quantified and subtracted; and then the remainder is allocated among pollutant sources. When the breakdown and allocation are completed the result is a TMDL, which must equal the load capacity.

Another step in a loading analysis is the quantification of current pollutant loads by source. This allows the specification of load reductions as percentages from current conditions, considers equities in load reduction responsibility, and is necessary in order for pollutant trading to occur. The load capacity must be based on critical conditions – the conditions when water quality standards are most likely to be violated. If protective under critical conditions, a TMDL will be more than protective under other conditions. Because both load capacity and pollutant source loads vary, and not necessarily in concert, determination of critical conditions can be more complicated than it may appear on the surface.

A load is fundamentally a quantity of a pollutant discharged over some period of time, and is the product of concentration and flow. Due to the diverse nature of various pollutants, and the difficulty of strictly dealing with loads, the federal rules allow for “other appropriate measures” to be used when necessary. These “other measures” must still be quantifiable, and relate to water quality standards, but they allow flexibility to deal with pollutant loading in more practical and tangible ways. The rules also recognize the particular difficulty of quantifying nonpoint loads and allow “gross allotment” as a load allocation where available data or appropriate predictive techniques limit more accurate estimates. For certain pollutants whose effects are long term, such as sediment and nutrients, EPA allows for seasonal or annual loads.

5.1. In-stream Water Quality Targets

In-stream water quality targets are discussed separately for the sediment TMDL and the temperature TMDL.

5.1.1. Sediment TMDL In-stream Water Quality Targets

This TMDL addresses sediment in the Cow Creek and Deep Creek watersheds. Deep Creek is also on the 1998 §303(d) list for temperature which is discussed separately throughout this section. The in-stream water quality target for the Cow and Deep Creek sediment TMDL is full support of the cold water aquatic life designated uses (Idaho Code 39.3611, .3615). Specifically, sedimentation must be reduced to a level where full support of beneficial uses is demonstrated using the current assessment method accepted by DEQ at the time the water body is reassessed.

The sediment TMDL will develop loading capacities in terms of mass per unit time. The interim goals will be set based on conditions in other watersheds supporting the cold water use and the final goals will be established when biomonitoring demonstrates full support of the cold water use. The sources yielding sediment to the system can be reduced, but a substantial period (up to 30 years) will be required for the stream to clear its current sediment bed load and create pools.

5.1.2. Temperature TMDL In-stream Water Quality Targets

For the Deep Creek and Boundary Creek temperature TMDLs, DEQ is utilizing a potential natural vegetation (PNV) approach. According to Idaho water quality standards (IDAPA 58.01.02.200.09), if natural conditions exceed numeric water quality criteria, exceedance of the criteria is not considered a violation of water quality standards. In these situations, natural conditions essentially become the water quality standard, and the natural level of shade and channel width become the target of the TMDL. The instream temperature resulting from attainment of these conditions is consistent with the water quality standards, even though it may exceed numeric temperature criteria. See Appendix B for further discussion of water quality standards and background provisions. The PNV approach is detailed below, including the procedures and methodologies for developing PNV target shade levels and estimating existing shade levels. For a more complete discussion of shade and its effects on stream water temperature, the reader is referred to the South Fork Clearwater Subbasin Assessment and TMDL (DEQ 2004, available online at http://www.deq.idaho.gov/water/data_reports/surface_water/tmdls/clearwater_river_sf/clearwater_river_sf.cfm).

5.1.2.1. Potential Natural Vegetation for Temperature TMDLs

There are several important contributors of heat to a stream including ground water temperature, air temperature, and direct solar radiation (Poole and Berman 2001). Of these, direct solar radiation is the source of heat that is most likely to be controlled or manipulated. The parameters that affect or control the amount of solar radiation hitting a stream throughout its length are shade and stream morphology. Shade is provided by the surrounding vegetation and other physical features such as hillsides, canyon walls, terraces, and high banks. Stream morphology affects how closely riparian vegetation grows together and water storage in the alluvial aquifer. Streamside vegetation and channel morphology are factors influencing shade that are most likely to have been influenced by anthropogenic activities, and which can most readily be corrected and addressed by a TMDL. Generally, riparian vegetation provides a substantial amount of shade on a stream only when it is very close to the stream, however, vegetation further away from the riparian corridor can provide shade depending on how much vertical elevation surrounds the stream.

DEQ can determine the amount of shade a stream enjoys by using one or both of the following types of measurements:

- **Effective shade**, which is the shade provided by all objects that intercept the sun as it makes its way across the sky, can be measured in a given spot with a solar pathfinder or with optical equipment similar to a fish-eye lens on a camera. Effective shade can also be modeled using detailed information about riparian plants and their communities, topography, and the stream's aspect. In addition to shade.
- **Canopy cover** is a similar parameter that affects the amount of solar radiation a stream receives. Canopy cover is the vegetation that hangs directly over the stream, and can be measured using a densiometer, or can be estimated visually either on site or using aerial photography.

Both these methods provide us information about how much of the stream is covered and how much of it is exposed to direct solar radiation.

Potential natural vegetation (PNV) along a stream is the intact riparian plant community that has grown to its fullest extent and has not been disturbed or reduced in any way. The PNV believed to have existed before any disturbance can be considered a basis for comparison. The PNV can be removed by disturbance either naturally (wildfire, disease/old age, wind-blown, wildlife grazing) or anthropogenically (domestic livestock grazing, vegetation removal, erosion). The idea behind using PNV as targets for temperature TMDLs is that PNV provides a natural level of solar loading to the stream. DEQ can estimate PNV from models of plant community structure and can measure existing vegetative cover or shade. Comparing the two will tell us how much excess solar load the stream is receiving, and what can be done to decrease solar gain.

Existing shade or cover was initially estimated for Boundary Creek (U.S. portion) and Deep Creek (McArthur Lake to mouth) from visual observations of aerial photos. These estimates were then field verified by measuring shade with a solar pathfinder at systematically located points along the streams (see below for methodology). The PNV targets were determined by analyzing probable natural vegetation at these two creeks and comparing it to shade curves developed for similar vegetation communities in other TMDLs. A shade curve shows the relationship between stream width and effective shade. As a stream gets wider, the shade decreases as the vegetation has less ability to shade the center of wide streams. As the vegetation gets taller, the plant community is able to provide more shade at any given channel width. Existing shade and PNV shade were converted to solar load from data collected on flat plate collectors at the nearest National Energy Research Laboratory weather stations that collect these data. In this case, an average from the two nearest stations (at Kalispell, Montana and Spokane, Washington) was used. The difference between existing and potential solar load, assuming existing load is higher, is the load reduction necessary to bring the stream back into compliance with water quality standards (see Appendix B). PNV shade and loads are assumed to be the natural condition, thus stream temperatures under PNV conditions are assumed to be natural (so long as there are no point sources or any other anthropogenic sources of heat in the watershed), and are thus considered to be consistent with the Idaho water quality standards, even though in stream temperature information may exceed numeric criteria.

5.1.2.2. Pathfinder Methodology

The solar pathfinder is a device that allows a person to trace the outline of shade-producing objects on charts already printed with monthly solar paths. The percentage of the sun's path covered by these objects is the effective shade on the stream at the spot that the tracing is made. In order to adequately characterize the effective shade on a reach of stream, ten traces should be taken at systematic or random intervals along the length of the stream in question.

At each sampling location the solar pathfinder should be placed in the middle of the stream about one foot above the water and the manufacturer's instructions for taking traces followed, including orienting it to true south and leveling. Systematic sampling is easiest to accomplish without biasing the location of sampling. To systematically choose sampling locations, start at a unique location such as 100 m from a bridge or fence line and then proceed upstream or downstream stopping to take additional traces at fixed intervals (e.g., every 100m, every half-mile, every degree change on a GPS, every 0.5 mile change on an odometer). Randomly located points of measurement can also be chosen by generating random numbers to be used as interval distances.

It is a good idea to take notes while taking solar pathfinder traces, and to photograph the stream at several unique locations, paying special attention to changes in riparian plant communities and noting the kinds of plant species (the large, dominant, shade producing ones) are present. Additionally or as a substitution, a person can take densiometer readings, to measure canopy cover at the same location as solar pathfinder traces are taken to measure effective shade. This provides the potential to determine relationships between canopy cover and effective shade for a given stream.

5.1.2.3. Aerial Photo Interpretation Methodology

In this method, canopy coverage estimates or expectations of shade based on plant type and density are provided for 200-foot elevation intervals, or natural breaks in vegetation density, marked out on a 1:100K topology map. Each interval is assigned a single value representing one of the shade classes specified in the chart below. There are ten shade classes, one for every 10% interval – all values within a 10% range are assigned the smallest value in the range. For example, if canopy cover for a particular stretch of stream is estimated to be between 50% and 59%, the value of 50% is assigned to that section of stream. The estimate is based on a general intuitive observation about the kind of vegetation present, its density, and the width of the stream. The typical vegetation type (below) shows the kind of landscape a particular cover class usually falls into. For example, if a section of stream is identified as 20% cover class, it is usually because it is in agricultural land, meadows, open areas, or clearcuts. However, that does not mean that the 20% cover class cannot occur in shrublands and forests, as it does on very wide streams.

Cover class	Typical vegetation type
0 = 0 – 9% cover	agricultural land, denuded areas
10 = 10 –19%	agricultural land, meadows, open areas, clearcuts
20 = 20 – 29%	agricultural land, meadows, open areas, clearcuts
30 = 30 – 39%	agricultural land, meadows, open areas, clearcuts
40 = 40 – 49%	shrublands/meadows
50 = 50 – 59%	shrublands/meadows, open forests
60 = 60 – 69%	shrublands/meadows, open forests
70 = 70 – 79%	forested
80 = 80 – 89%	forested
90 = 90 –100%	forested

It is important to note that the visual estimates made from the aerial photos are of canopy cover, not shade. DEQ assumes that canopy coverage and shade are similar based on research conducted by Oregon DEQ (OWEB 2001). The visual estimates of cover in this TMDL were field verified with solar pathfinder measurements of shade. The pathfinder measures effective shade and takes into consideration other physical features that block the sun from hitting the stream surface (e.g., hillsides, canyon walls, terraces, man-made structures). The estimate of cover made visually from an aerial photo does not take into account topography or any shading that may occur from physical features other than vegetation. However, research has shown that shade and cover measurements are remarkably similar (OWEB 2001), reinforcing the idea that riparian vegetation and objects proximal to the stream provide the most shade.

5.1.2.4. Stream Morphology

Measures of current bankfull width or near stream disturbance zone width may not reflect widths that were present under PNV conditions. As impacts to streams and riparian areas occur, width-to-depth ratios tend to increase as streams become wider and shallower. Shadow length produced by vegetation covers a smaller percentage of the water surface in wider streams. Widened streams can also have less vegetative cover if shoreline vegetation has been eroded away.

Shade target selection, which involves evaluating the amount of shade provided at PNV conditions, necessitates determination of potential natural stream widths as well. In this TMDL appropriate stream widths for shade target selection were determined from analysis of existing stream widths and the relationship between drainage area and width-to-depth ratios (Rosgen 1996). See Appendix B for more discussion on determining appropriate stream widths. Because the majority of the Boundary Creek watershed is in Canada, and because the watershed is relatively unaltered, its existing stream widths (23m) are used in the target selection process.

The drainage area for Deep Creek is roughly 181 mi^2 with 129 mi^2 above Brown Creek. Deep Creek natural stream widths below Brown Creek (Rosgen C type) were likely in the neighborhood of 20m (66ft) as determined from Figure B-2 (in Appendix B). Existing stream widths were measured to be about 25m at the second lowest pathfinder verification site (i.e., the second to the last site going downstream, or second upstream from the mouth of the creek), which is within this section of Deep Creek.

The drainage area for McArthur Lake and Deep Creek above Trail Creek is about 41 mi^2. Therefore, natural stream widths from McArthur Lake to Brown Creek (Rosgen C type) were determined from Figure B-2 to be about 10m (33ft). Existing stream widths, measured within this stretch at various BURP and pathfinder sites, range from 8.9m to 19m with an average of about 13m (43ft). Thus, existing stream widths are slightly larger than the natural stream width determined for this section of the creek. One complication in the process of determining natural stream width is that the effects of McArthur Lake and its human-made control structures are unknown.

At the mouth of Deep Creek, high water backing up from the Kootenai River affects the size of the near stream disturbance zone visible in Figure 23. Hence, natural channel widths at the mouth are altered by inundation. Although Figure B-2 in Appendix B suggests that natural channel widths for the mouth of Deep Creek should be in the neighborhood of 23-25m, the existing near stream disturbance zone at the mouth (Figure 23) is about 60m. DEQ chose to use the existing near stream disturbance zone width of 60m for the target width at the mouth of Deep Creek, because it was assumed that the inundation process, caused by downstream dam operations, was not controllable or reversible.

5.1.3. Design Conditions

Design conditions are discussed separately for the sediment TMDL and the temperature TMDL.

5.1.3.1. Sediment TMDL Design Conditions

All sources of sediment to Cow Creek and Deep Creek are nonpoint sources. This TMDL addresses the nonpoint sediment yield to the watershed. Sediment from nonpoint sources is loaded episodically, primarily during high discharge events. These critical events coincide with critical conditions. These events typically occur between November through May, but may not occur for several years. The typical return time of the largest events is 10-15 years (DEQ 2001). The critical stream reaches are the Rosgen B channel types that naturally harbor the most robust cold water communities, but have gradients sufficiently low for coarse bedload to accumulate and fill pools. The key to nonpoint source sediment management is to implement remedial activities prior to the advent of a large discharge event. Large discharge events are the only mechanism of transporting coarse sediments downstream.

5.1.3.2. Temperature TMDL Design Conditions

Design conditions for the temperature TMDL are divided into those for Boundary Creek and those for Deep Creek.

5.1.3.2.1. Boundary Creek – Potential Natural Vegetation

Boundary Creek flows from west to east through the very tip of the Idaho panhandle. Boundary Creek enters Idaho from British Columbia, Canada on the west end, flows approximately 6.5 miles eastward through the Panhandle National Forest, then leaves the National Forest and flows about 0.5 miles through private land before it enters a linear channel on the Canadian side of the border just prior to entering the Kootenai River.

The majority of this watershed is forested. Although not mapped in the Boundary County Soil Survey (Chugg and Fosberg 1980), soils on the north-facing southern side of Boundary Creek are likely to be of the Pend Orielle-Idamont association. These glaciated mountainsides support a potential natural community of western hemlock (*Tsuga heterophylla*) and western redcedar (*Thuja plicata*), with lesser amounts of grand fir (*Abies grandis*), Douglas fir (*Psuedotsuga menziesii*), western white pine (*Pinus monticola*), and western larch (*Larix occidentalis*). Soils on the south-facing northern side of Boundary Creek are likely of the Rock outcrop-Treble complex. Soils of the Treble series are found on southwest facing glaciated mountainsides, and support a Douglas fir (*P. menziesii*), ponderosa pine (*Pinus ponderosa*), and snowberry (*Symphorocarpus sp.*) community (Chugg and Fosberg 1980). Soils outside the national forest boundary near the mouth of Boundary Creek are Bane loamy fine sand typically found on alluvial fans at the mouths of steep canyons (Chugg and Fosberg 1980). Potential natural vegetation on these soils include ponderosa pine, Douglas fir, black cottonwood (*Populus trichocarpa*), and pinegrass (*Calamagrostis sp.*).

5.1.3.2.2. Deep Creek – Potential Natural Vegetation

Deep Creek generally flows south to north from McArthur Lake to the Kootenai River. For most of its length, riparian soils along Deep Creek are Seelovers silt loam (Chugg and Fosberg 1980). The potential natural vegetation associated with this soil was mixed deciduous trees and shrubs with some occasional conifers. Trees included black cottonwood, paper birch (*Betula papyrifera*), western red cedar, and Douglas fir (Chugg and Fosberg 1980, Jankovsky-Jones 1996). Shrubs likely included red osier dogwood (*Cornus sericea*), mountain alder (*Alnus incana*), Douglas hawthorn (*Crataegus Douglasii*), chokecherry (*Prunus virginiana*), and various willows (*Salix sp.*) (Jankovsky-Jones 1996). Deep Creek bottomland where the creek enters the Kootenai River floodplain is underlain by Farnhamton silt loam soils, and supported a black cottonwood gallery forest with deciduous shrubs (willows) and occasional conifers (Douglas fir) (Chugg and Fosberg 1980).

5.1.4. Target Selection

Target selection is discussed separately for the sediment TMDL, which includes discussion of modeling sediment yield from a disturbed landscape, and the temperature TMDL.

5.1.4.1. Sediment TMDL Target Selection

The TMDL applies sediment allocations in tons per year and calculates sediment reduction goals.

The load capacity rate at which full support is exhibited has been set at various levels in TMDLs developed by DEQ. These have ranged from setting an interim load capacity at the background level for some watersheds in the Coeur d'Alene Lake Subbasin and the Pend Oreille basin, to more than 200% above background in some areas of the state. Evidence is beginning to support that a target of 50% above background is protective of the beneficial uses in the Lower Kootenai and Moyie River Subbasins. This target is far more conservative (protective) when compared to previously set load capacities of other Panhandle TMDLs. Similar rationale used in previous TMDLs can be used to support the more conservative target.

The rationale supplied in those TMDLs in support of the target was based on several premises (DEQ 2001):

- Sediment yield less than 50% above background will fully support the beneficial uses of cold water aquatic life and salmonid spawning.
- Beneficial uses (cold water aquatic life and salmonid spawning) will be fully supported when the finite but not quantified ability of the stream system to process (attenuate) sediment is met.

Data collected within the Lower Kootenai River Subbasin appears to support the target of 50% above background. A comparison of WBAG II scores to the modeled percentage above background estimates for sediment is shown in Figure 21. In the green shaded area, the two coincide: the WBAG II score indicates full support (not impaired) and the modeled percentage above background is less than 50%. The two also coincide in the red shaded area: the WBAGII scores indicate the stream is impaired and the modeled percentage above background is greater than 50%.

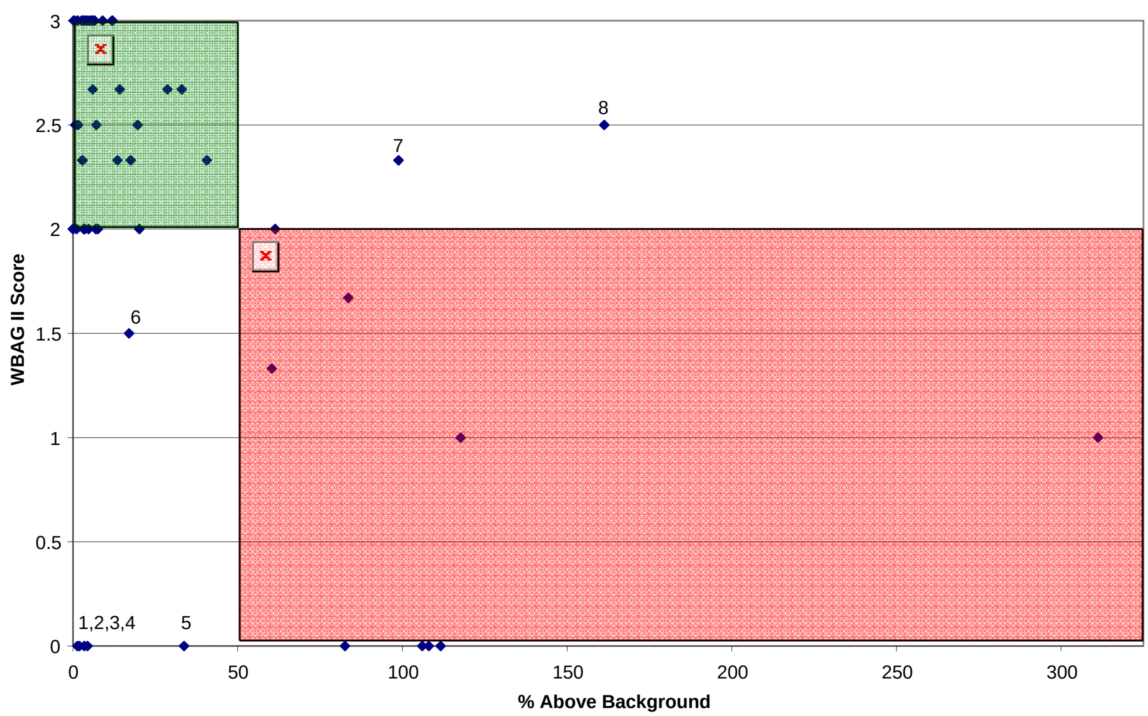

Figure 21. Sediment WBAGII scores versus modeled percentage above background

For the eight cases in which the two do not coincide (points labeled 1-8 on Figure 21), the notes below describe conditions at each site.

1. Boulder Creek (1995SCDAA074): large substrate size: difficult to collect representative macroinvertebrate sample. Large substrate size may also contribute to poor macroinvertebrate habitat.
2. Boulder Creek (1995SCDAA073): large substrate size; difficult to collect representative macroinvertebrate sample. Large substrate size may also contribute to poor macroinvertebrate habitat.
3. Boundary Creek (2001SCDAE034): downstream from Blue Joe Creek, which is §303(d) listed for metals and pH. Metals and pH exceedances are contributing to a low WBAG II score for Boundary Creek.

4. Rock Creek (2001SCDAA003): 1st order stream with very low flows (0.1 cfs). Low flows inhibit the development of a sustainable macroinvertebrate community, without a macro community a food chain is unable to develop, which affects the fish population.
5. Fisher Creek (2001SCDAA023): bedrock substrate resulting in less than ideal sampling conditions and a lack of sufficient macroinvertebrate habitat.
6. Blue Joe Creek (1995SCDAA070): also listed for pH and metals exceedances. Metals and pH exceedances are adversely affecting macroinvertebrate and fish communities.
7. East Fork Meadow Creek (1995SCDAB042): watershed maybe unaffected by sediment, therefore unresponsive to changes in sediment delivery.
8. Highland Creek (2001SCDAA046): watershed maybe unaffected by sediment, therefore unresponsive to changes in sediment delivery.

In all but the eight instances for which conditions are described above, the WBAG II score and the percentage of background sediment coincide. Watersheds where they do not coincide may be affected by conditions other than sediment and may therefore be unresponsive to changes in sediment delivery to the stream. For instance, Blue Joe Creek (point 6 on Figure 21 and note 6) is also listed for pH and metal exceedances, which may be adversely affecting its macroinvertebrate and fish communities, although it is experiencing very little sediment delivered to the stream. Blue Joe Creek has a passing habitat score (in spite of a failing overall/average score); however, no fish were collected and its macroinvertebrate score is low. For Boulder Creek and Fisher Creek (points 1, 2, and 5 on Figure 21 and notes 1, 2, and 5), which also have sediment levels below the 50% above background threshold but have failing WBAG II scores, the failing scores maybe a reflection of difficult sampling conditions. The Boulder Creek substrate consists of large cobble- to boulder-sized particles and in Fisher Creek exposed bedrock may have made macroinvertebrate sampling difficult. In the Fisher Creek watershed, observed natural fish barriers may also be contributing to a low WBAG II score.

According to the evidence outlined above, the 50% above background target appears to be reasonable and protective of the beneficial uses of the watersheds in the Lower Kootenai River Subbasin. Therefore, the target load capacity for sediment in Cow and Deep Creeks is set at 50% above background.

The goal should be attained following three high flow events after implementation plan actions are in place. Based on the average recurrence of high flow events, this should take about 30 years. This time is necessary for the channel-forming events needed to export sediment and to create pool structures.

5.1.4.1.1. Modeling Sediment Yield From a Disturbed Landscape

High and low density development land use designations were developed by interpreting known structure (buildings) locations. A GIS density function was applied to structure locations to determine an appropriate land use distribution. The point density function was used to calculate the density of structures around a specified area. Conceptually, an area is centered on a center cell, and the number of points that fall within the specified area is totaled and divided by the area. Although primitive, this was the best known way to incorporate known but not explicitly identified sediment contributors within the watershed associated with rural development.

An area of approximately one mile diameter was applied to structures in the basin. An area this size is expected to incorporate road networks and other infrastructure associated with development. Changing the radius size would directly affect the outcome of the development land use coverage. More information is needed to determine the appropriate area of impact caused by rural home sites and to adjust the neighborhood radius accordingly.

Once the development coverage was created it was then overlain by an acreage coverage distinguished by land manager. Land uses were assigned to land managers regardless of modeled land use type. In this step land managers may be assigned land use types which are not observed within lands they manage. This edge effect is most commonly observed with high and low density development land use types.

Differentiation between high and low density development was computed based on the number and distance between known structures. A high number of structures in a confined location resulted in a high density development classification. A low number of structures distributed in a broad area received a low density development classification. High density development is generally centered around the towns of Bonners Ferry, Moyie Springs, Porthill, East Port, Naples, and McArthur. Low density development is mostly contained within, but not limited to, the Lower Kootenai and Moyie River valleys

5.1.4.1.1.1. Limitations

The lack of data associated with rural development surface water impacts creates difficulties when trying to model rural development sediment yield. Future monitoring will help to close these data gaps and develop more reliable and realistic sediment reduction goals allocated to high and low density development. Specifically more information is needed on the size of home sites, infrastructure associated with each site, and the nature in which adjacent land is managed. Monitoring and surveying of rural development will also help to define the causes of sediment and how to mitigate against sediment generation to surface water.

5.1.4.1.1.2. Burn/Shrub sediment yield

Similar to the high and low density development sediment yield coefficients, burn/shrub areas identified in the upper Cow Creek watershed were modeled using an unsubstantiated coefficient. Personal knowledge of sediment export, along with comparison of data used to develop other sediment yield coefficients, was collaborated to determine appropriate sediment yield expectations. Additional monitoring would be helpful in determining the most appropriate burn/shrub sediment yield coefficient.

5.1.4.1.1.3. Pipeline sediment yield

Sediment yield to surface water associated with pipelines is limited to construction and is not a chronic source of sediment. Data were supplied to DEQ by Gas Transmissions Northwest pertaining to pipeline crossings causing surface water impacts. A regression analysis was applied to the data in order to determine the most appropriate sediment yield coefficient to be used in the Lower Kootenai and Moyie River Subbasin sediment model. Modeled results indicate that pipeline sediment yield accounts for only 1.7% of the load reductions within the basin. Minor sediment reductions mirror the minor acreage dedicated to the pipeline land use type.

5.1.4.1.1.4. *Agriculture sediment yield coefficients*

Valley and bench agriculture coefficients were developed using the Revised Universal Soil Loss Equation version 2 (RUSLE2). RUSLE2 was developed to inventory erosion rates and estimate sediment delivery. Valley agriculture areas were modeled to have a lower sediment delivery coefficient than natural background conditions because of an extensive dike system built near the turn of the century. Valley land has been diked and drained to create farmland. The use of dikes in the valley agriculture areas restricts sediment delivery to surface water. One pumping station is located near the Deep Creek confluence with the Kootenai River (personal communication, Scott Bacon 2005). Pumping is conducted to remove water from agricultural areas. Before water is pumped into the Kootenai River, sediment is settled out, resulting in little sediment delivery to the river.

Valley agriculture is modeled to be within the floodplain adjacent to the Kootenai River. Valley agriculture land use type is most notable in the Deep Creek watershed. Valley agriculture land use is noted occurring near the confluence of the Kootenai River in other watersheds on a limited scale.

5.1.4.2. Temperature TMDL Target Selection

To determine potential natural vegetation shade targets for Deep and Boundary Creeks, effective shade curves from several existing temperature TMDLs were examined. These TMDLs had previously used vegetation community modeling to produce these shade curves. For Deep and Boundary Creeks, curves for the most similar vegetation type were selected for shade target determinations. Because no two landscapes are exactly the same, shade targets were derived by taking an average of the various shade curves available. Effective shade curves include percent shade on the vertical axis and stream width on the horizontal axis. As a stream becomes wider, a given vegetation type loses its ability to shade the stream.

The effective shade calculations are based on a six month period from April through September. However, the critical time period when temperatures affect beneficial uses occurred in June through September when spring and fall salmonids spawning temperatures were exceeded in both creeks and when cold water aquatic life criteria were exceeded in Deep Creek (see temperature data in Appendix C). Late July and early August are the period of highest stream temperatures (however, cold water aquatic life criteria were not violated in Boundary Creek (Figure C-1)). Solar gains can begin early in the spring and affect not only the highest temperatures reached later on in the summer, but solar loadings affect salmonids spawning temperatures in spring and fall. Thus, solar loading in these streams is evaluated from spring (April) to early fall (September).

5.1.4.2.1. Boundary Creek

For Boundary Creek an attempt was made to match a western hemlock/western redcedar forest type. Although the south-facing side of the canyon is largely Douglas fir/ponderosa pine, the near stream vegetation on the north side is likely more mesic and resembles the south side (see Figure 22).

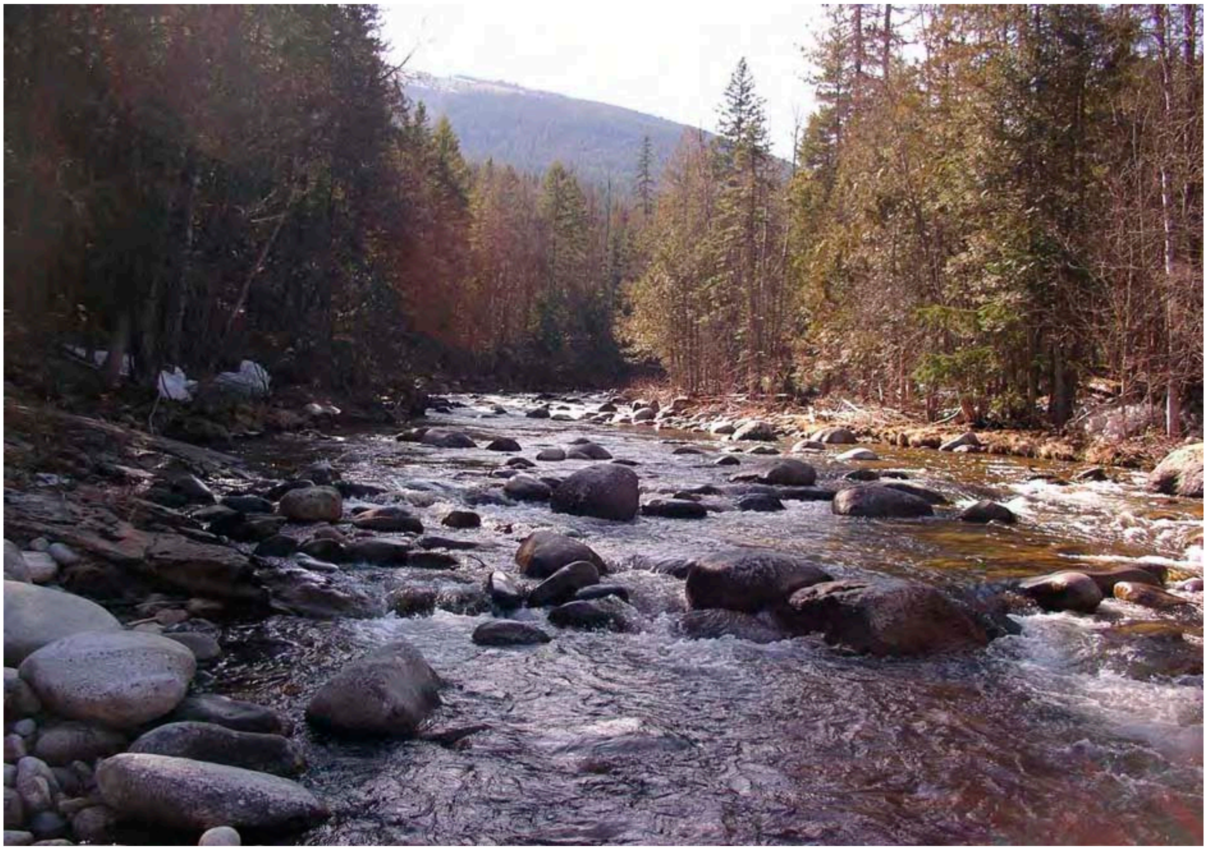

Figure 22. Boundary Creek near stream vegetation.

Effective shade curves from four TMDLs were used. Using an average stream width of 23m (from bankfull width measurements at six BURP sites and recent measurements taken during solar pathfinder sampling in March 2005), the following effective shade levels were observed in these TMDLs:

1. South Fork Clearwater River TMDL (IDEQ 2004), stream breaklands, cedar and grand fir type = 55% effective shade at 23m.
2. Willamette Basin TMDL (ODEQ 2004a), Western Cascade Range geomorphology (Tvw) = 60% effective shade at 23m.
3. Walla Walla River TMDL (ODEQ 2004b), conifer zone = 50% effective shade at 23m.
4. Mattole River TMDL (CRWQCB 2002), Klamath mixed conifer forest = 65% effective shade at 23m.

Although these TMDLs reflect a wide variety of geomorphologies and topographies, effective shades at a 23m stream width were remarkably similar. For Boundary Creek, an average of these four effective shades (58%) was rounded to 60% and selected as the target effective shade level for this TMDL.

5.1.4.2.2. Deep Creek

Deep Creek below McArthur Lake was separated into three reaches for shade target development (see Stream Morphology section 5.1.2.4). The portion above Lake McArthur was not included in the analysis. In the upper evaluated reach, bankfull widths measured at

BURP and other sites averaged about 13m. Because natural widths were likely to be less than present day widths, 10m width was chosen to represent the majority of the watershed from McArthur Lake to about Brown Creek (see previous discussion on stream morphology).

The second reach is about 4.7 miles of stream in a valley that is wider then the rest of the watershed above it. A width of 20m was chosen to represent stream widths in this second reach.

The lowest reach of 1.5 miles on the Kootenai River floodplain was treated as the third reach. The bottomland portion of Deep Creek has channel widths that are substantially larger than those of upper Deep Creek (60m estimated from maps and aerial photos) because of the influence of levees and the Kootenai River. This wider near stream disturbance zone can be seen in the photograph in Figure 23.

Figure 23. Deep Creek bottomland near the Kootenai River. The near stream disturbance zone is larger than banks due to periodic inundation during high flows.

Again, effective shade curves from four TMDLs (three of them the same as those used for Boundary Creek) were used to produce average shade targets for upper, middle and lower Deep Creek. Using average stream widths of 60m for the bottomland, 20m for middle Deep Creek and 10m for upper Deep Creek, the following effective shade levels were observed from these TMDLs:

1. Alvord Lake TMDL (ODEQ 2003), black cottonwood/pacific willow type =

    40% effective shade at 60m
    70% effective shade at 20m
    80% effective shade at 10m.
2. Walla Walla River TMDL (ODEQ 2004b), deciduous-conifer zone =

    30% effective shade at 60m
    60% effective shade at 20m
    70% effective shade at 10m.
3. Mattole River TMDL (CRWQCB 2002), mixed hardwoods-conifer forest =

    30% effective shade at 60m
    68% effective shade at 20m
    82% effective shade at 10m.
4. Willamette Basin TMDL (ODEQ 2004a), alluvium of small streams (Qalf) geomorphology =

    22% effective shade at 60m
    40% effective shade at 20m
    55% effective shade at 10m.

Again, effective shade from differing TMDLs are similar at the same stream width. An average of the effective shade values from these four TMDLs was used for targets in Deep Creek. For the Deep Creek bottomland (lowest 1.5 miles) an effective shade target of 30% was chosen, for the middle portion of Deep Creek the effective shade target is 60%, and for upper Deep Creek, the effective shade target is 72%.

5.1.5. Compliance Points and Monitoring

Compliance points and monitoring are discussed separately for the sediment TMDL and the temperature TMDL.

5.1.5.1. Sediment TMDL Compliance Points and Monitoring

The point of compliance for Cow Creek is approximately three miles above its mouth (BURP ID 1995SCDAB041) and Deep Creek's point of compliance is approximately 2.5 miles above its confluence with the Kootenai River (BURP ID 2001SCDAA045). The sediment load reduction from the current level (Cow Creek is currently at 76% more than background; Deep Creek is currently at 75% above background) toward the goal of 50% more than background is expected to reduce sediment to a load that, although not yet quantified, will fully support beneficial use (cold water aquatic life). Beneficial use support status will be determined using the current assessment method accepted by DEQ at the time the water body is monitored. Monitoring will be completed using BURP protocols. When the final sediment load capacity is determined by these appropriate measures of full cold water aquatic life support, the TMDL will be revised to reflect the established supporting sediment yield.

5.1.5.2. Temperature TMDL Compliance Points and Monitoring

Effective shade monitoring can take place on any reach throughout the Deep and Boundary Creek watersheds and compared to estimates of existing shade given in Tables 18 and 19. Those areas with the lowest existing shade estimates should be monitored with solar pathfinders to verify the existing shade levels and to determine progress toward meeting shade targets. Stream segments divided by each change in existing shade level vary in length depending on land use or landscape that has affected shade. It is appropriate to monitor within a given existing shade segment to see if existing shade in that segment has increased toward its target level. Five to ten equally spaced solar pathfinder measurements within a segment should suffice to determine new shade levels in the future.

5.2. Load Capacity

Load capacities for the sediment TMDL are discussed below. Temperature load capacity is discussed in section 5.3.2.

5.2.1. Sediment TMDL Load Capacity

The load capacity for a TMDL designed to address a sediment-caused limitation to water quality is complicated by the fact that the state's water quality standard is a narrative rather than a quantitative standard. In the waters of Cow and Deep Creeks, the sediment interfering with the beneficial use (cold water) is most likely large bed load material. Adequate quantitative measurements of the effect of excess sediment have not been developed. Given this difficulty, an exact sediment load capacity for the TMDL is difficult to develop.

The natural background sedimentation rate is the sediment yield prior to anthropogenic influences in the watershed. It was calculated by multiplying the Cow Creek (13,528 acres) and Deep Creek (116,760 acres) watershed acreages by the sediment yield coefficient for a mixed geologic setting. The sediment yield rate is an average of granitic and belt supergroup terrain vegetated by coniferous forests. The sediment yield coefficient for granitic geologies is 0.036 tons/acre/year (t/a/y) and the sediment yield coefficient for belt supergroup terrain is 0.023 t/a/y. The estimate assumes the entire watershed was vegetated by coniferous forest prior to development. As shown in Table 14, the estimated natural background value for the entire Cow Creek watershed is 405 tons per year and for Deep Creek it is 3,491 tons per year (Table 15). Thus, the 50% above background sediment yield goals equal 608 and 5,237 tons per year, respectively.

Table 14. Cow Creek sediment load, background, and load capacity at the point of compliance.

Load Type	Location (BURP[1] Site ID Number)	Acreage of Watershed	Estimated Existing Load (tons/year)	Natural Background (tons/year)	Load Capacity at 50% Above Background (tons/year)	Estimation Method
Sediment	Cow Creek BURP ID 1995SCDA B041	13,528	713	405	608	Model

[1]Beneficial Use Reconnaissance Program

Table 15. Deep Creek sediment load, background, and load capacity at the point of compliance.

Load Type	Location (BURP[1] Site ID Number)	Acreage of Watershed	Estimated Existing Load (tons/year)	Natural Background (tons/year)	Load Capacity at 50% Above Background (tons/year)	Estimation Method
Sediment	Deep Creek BURP ID 2001SCDA A045	116,760	6,122	3,491	5,237	Model

[1]Beneficial Use Reconnaissance Program

The load capacity was developed by calculating background sedimentation based on acreage above the point of compliance, then adding an additional 50% to the value. The goal is an estimated goal that will be replaced by the final sediment goal when the criteria for full support of cold water use are met.

5.2.1.1. Seasonality and Critical Conditions Affecting Sediment Load Capacity

Sediment from nonpoint sources is not delivered to streams seasonally. It is delivered episodically, primarily during high discharge events. These critical events coincide with the critical conditions and typically occur during November through May. However, such events may not occur for several years. The return time of the largest events is usually 10-15 years (DEQ 2001).

Critical conditions are part of the analysis of load capacity. The beneficial uses in this subbasin are impaired due to chronic sediment conditions. Due to the chronic condition, this TMDL deals with yearly sediment loads. The concept of critical conditions is difficult to reconcile with the impact caused by sediment. The critical condition concept assumes that under certain conditions, chronic pollution problems become acute pollution problems. Therefore, it is important to ensure that acute conditions do not occur. The proposed sediment reductions in the TMDL will reduce the chronic sediment load and will also reduce the likelihood that an acute sediment loading condition will exist. It is in this way that critical conditions are accounted for in the TMDL.

5.2.2. Temperature TMDL Load Capacity

The loading capacity for a stream under PNV is essentially the solar loading allowed under the shade target levels specified for the reaches within that stream. These loads are determined by multiplying the solar load to a flat plat collector (under full sun) for a given period of time by the fraction of the solar radiation that is not blocked by shade (i.e., the percent open, which is equal to 1.0 minus the shade percentage). In other words, if a shade target is 60% (or 0.6), then the solar load hitting the stream under that target is 40% of the load hitting the flat plate collector under full sun.

DEQ obtained solar load data for flat plate collectors from two nearby National Renewable Energy Laboratory (NREL) weather stations. The two closest stations are in Kalispell, Montana and Spokane, Washington. Because the Kootenai Valley is located between these two stations, an average of values from the two stations was calculated. The solar loads used in this TMDL are spring/summer averages, thus, DEQ uses an average load for the six month period from April through September. These months coincide with the time of year that stream temperatures are increasing and deciduous vegetation is in leaf. Tables 18 and 19 show the PNV shade targets (identified as Target or Potential Shade) and their corresponding potential summer load (in kWh/m2/day and kWh/day) that serve as the loading capacities for the streams.

For Boundary Creek, DEQ has used the same red cedar/hemlock community PNV shade target (60%) for the entire reach (Table 18). Fore Deep Creek, DEQ has used the mixed deciduous trees and shrubs PNB target (60% and 72%) for all but the last 1.5 miles of stream. The bottomland of Deep Creek has the cottonwood gallery PNV shade target (30%)

5.3. Estimates of Existing Pollutant Loads

Regulations allow that loadings "...may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading," (Water quality planning and management, 40 CFR § 130.2(I)). An estimate must be made for each point source. Nonpoint sources are typically estimated based on the type of sources (land use) and area (such as a subwatershed), but may be aggregated by type of source or land area. To the extent possible, background loads should be distinguished from human-caused increases in nonpoint loads. Existing load estimates are discussed separately for the sediment TMDL and the temperature TMDL.

5.3.1. Sediment TMDL Estimates of Existing Pollutant Loads

Point sources of sediment do not exist in the Cow and Deep Creek watersheds. Nonpoint sources of sediment yield were estimated in Section 5.1.4.1. Loading rates were based on land use type. The estimated sediment loads from the watershed above the points of compliance were shown in Table 14 and Table 15.

Historic burn areas in Cow Creek, and residential development and stream bank erosion in Deep Creek are the largest sources of sediment in the watershed. The percentage of sediment delivery estimated according to the number of acres in each land use type, based on land ownership, is provided in Table 16 for Cow Creek and Table 17 for Deep Creek.

Table 16. Current loads from nonpoint sources in Cow Creek.

Land Use Type	Location	Load tons/year	Estimation Method
Roads	Cow Creek watershed	5	Model
Shrub/Historic Burn	Cow Creek watershed	485	Model
Acres at background coefficient	Cow Creek watershed	223	Model
Disturbed	Cow Creek watershed	negligible	Model
Total	-	713	-

Table 17. Current loads from nonpoint sources in Deep Creek.

Land Type	Location	Load tons/year	Estimation Method
Roads	Deep Creek watershed	122	Model
Acres at background coefficient	Deep Creek watershed	3,154	Model
Valley Agriculture	Deep Creek watershed	na	Model

Bench Agriculture	Deep Creek watershed	391	Model
Stream bank erosion	Deep Creek watershed	2,242	Model
Disturbed	Deep Creek watershed	95	Model
Pipeline	Deep Creek watershed	98	Model
Railroad	Deep Creek watershed	20	Model
Total	-	6,122	-

5.3.2. Temperature TMDL Estimates of Existing Pollutant Loads

Regulations all that loadings "…may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting allotments, depending on the availability of data and appropriate techniques for predicting the loading., (Water quality planning and management, 40 CFR § 130.2(I)). An estimate must be made for each point source. Nonpoint sources are typically estimated base on the type of sources (land use) and area (such as a subwatershed), but may be aggregated by type of source or land area. To the extent possible, background loads should be distinguished from human-caused increases in non-point loads.

Existing loads used in this temperature TMDL come from estimates of existing shade as determined from aerial photo interpretations. Like target shade, existing shade was converted to a solar load by multiplying the fraction of open stream by the solar radiation measured on a flat plate collector at the NREL weather stations. Existing shade data are presenting in figures 26 and 27 for Boundary Creek and Deep Creek, respectively.

Existing shade varied little over the entire reach of Boundary Creek in Idaho (Figure 26 and Table 18). Solar pathfinder data (average summer shade 'April through September' = 62.7%) taken in a section of boundary Creek that was estimated to have 60% shade verified the accuracy of the aerial photo interpretation. Existing shade estimates on Deep Creek, from aerial photo interpretation varied from a low of 10% to target levels (30%, 60%, or 72%,) (Figure 27 and Table 19). Solar pathfinder data used to verify aerial photo interpretation estimates on Deep Creek were initially taken at the mouth, where shade estimates were the lowest. In that reach, average summer shade (April through September) was measured as 5.5%, compared to the aerial photo estimate of 10%. More solar pathfinder measurements were taken later at additional points. All the points where solar pathfinder measurements were taken on Deep Creek are shown on Figure 28.

Table 18. Existing and Potential Solar Loads for Boundary Creek.

Segment Length (~miles)	Existing Shade (fraction)	Existing Summer Load (kWh/m^2/day)	Target or Potential Shade (fraction)	Potential Summer Load (kWh/m^2/day)	Potential Load minus Existing load (kWh/m^2/day)
6	0.6[a]	2.2	0.6	2.2	0.0
0.8	0.5	2.8	0.6	2.2	-0.6
0.3	0.6[b,c]	2.2	0.6	2.2	0.0
0.3	0.4	3.3	0.6	2.2	-1.1
Average	**0.5**	**2.6**	**0.6**	**2.2**	**-0.4**
Segment Length (meters)	Segment area (m^2)	Existing Summer Load (kWh/day)		Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)

9656	222088	488593.6		488593.6	0
1287	29601	81402.75		65122.2	-16280.55
483	11109	24439.8		24439.8	0
483	11109	36659.7		24439.8	-12219.9
Total		**631096**		**602595**	**-28500**

a - pathfinder field measurement of 52.3%
b - verified with solar pathfinder
c - field measured shade = 62.7%.

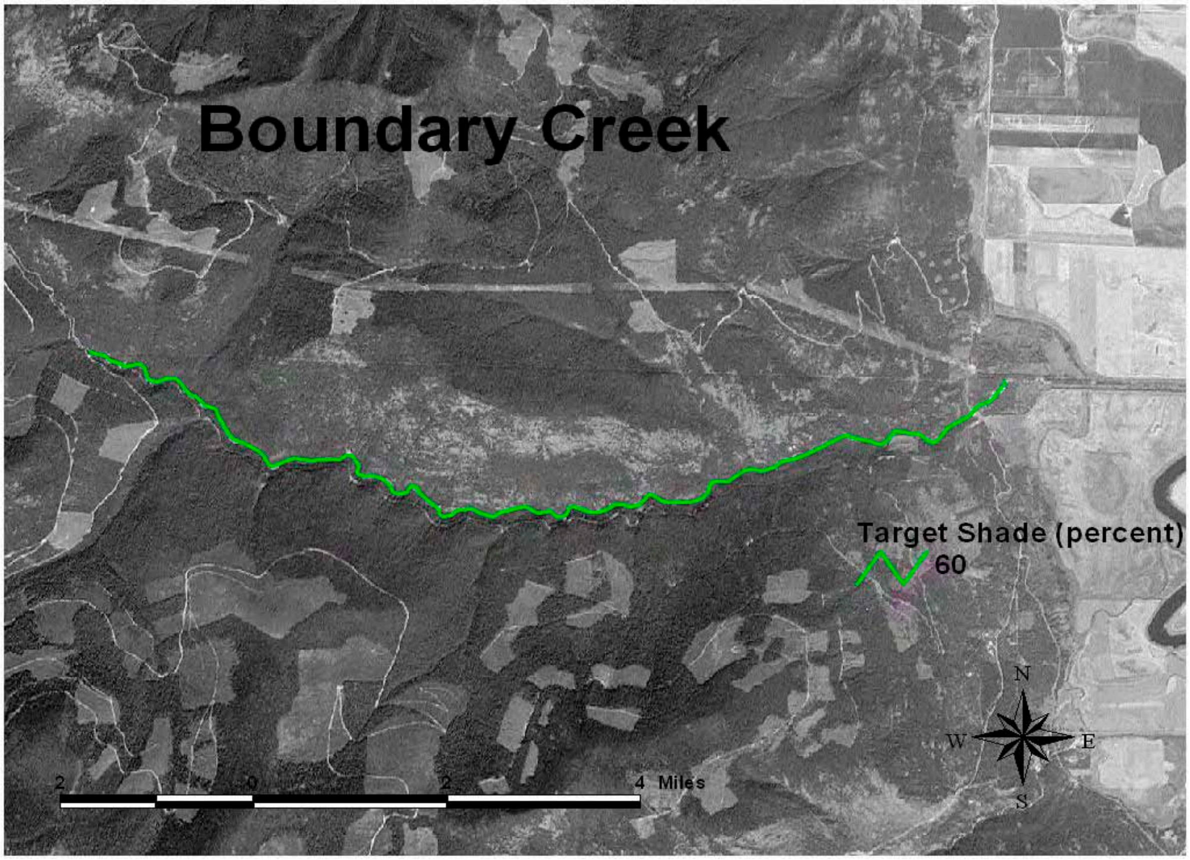

Figure 24. Target Shade for Boundary Creek.

Table 19. Existing and Potential Solar Loads for Deep Creek.

Segment Length (~miles)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Target or Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	
1.3 (start from lake)	0.6	2.2	0.72	1.54	-0.7	Mixed Deciduous Tree & Shrub
1	0.5	2.8	0.72	1.54	-1.2	10 meters wide
1.5	0.6	2.2	0.72	1.54	-0.7	
1	0.5	2.8	0.72	1.54	-1.2	
0.6	0.2	4.4	0.72	1.54	-2.9	
0.5	0.7	1.7	0.72	1.54	-0.1	
0.5	0.5	2.8	0.72	1.54	-1.2	
0.2	0.4	3.3	0.72	1.54	-1.8	
0.3	0.2	4.4	0.72	1.54	-2.9	
0.5	0.4	3.3	0.72	1.54	-1.8	
1.2	0.3	3.9	0.72	1.54	-2.3	
0.5	0.5	2.8	0.72	1.54	-1.2	
0.7	0.3	3.9	0.72	1.54	-2.3	
4.7	0.2	4.4	0.6	2.2	-2.2	20 meters wide
1.5	0.1*	5.0	0.3	3.85	-1.1	Cottonwood Gallery Forest (60m wide)
Average	**0.4**	**3.3**	**0.7**	**1.7**	**-1.6**	

*verified with solar pathfinder, field measured shade = 5.5%.

Segment Length (meters)	Segment Area (m²)	Existing Summer Load (kWh/day)		Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)
2092	20920	46024		32216.8	-13807.2
1609	16090	44247.5		24778.6	-19468.9
2414	24140	53108		37175.6	-15932.4
1609	16090	44247.5		24778.6	-19468.9
966	9660	42504		14876.4	-27627.6
805	8050	13282.5		12397	-885.5
805	8050	22137.5		12397	-9740.5
322	3220	10626		4958.8	-5667.2
483	4830	21252		7438.2	-13813.8
805	8050	26565		12397	-14168
1931	19310	74343.5		29737.4	-44606.1
805	8050	22137.5		12397	-9740.5
1127	11270	43389.5		17355.8	-26033.7
7564	151280	665632		332816	-332816
2414	144840	716958		557634	-159324
Total		**1846455**		**1133354**	**-713101**

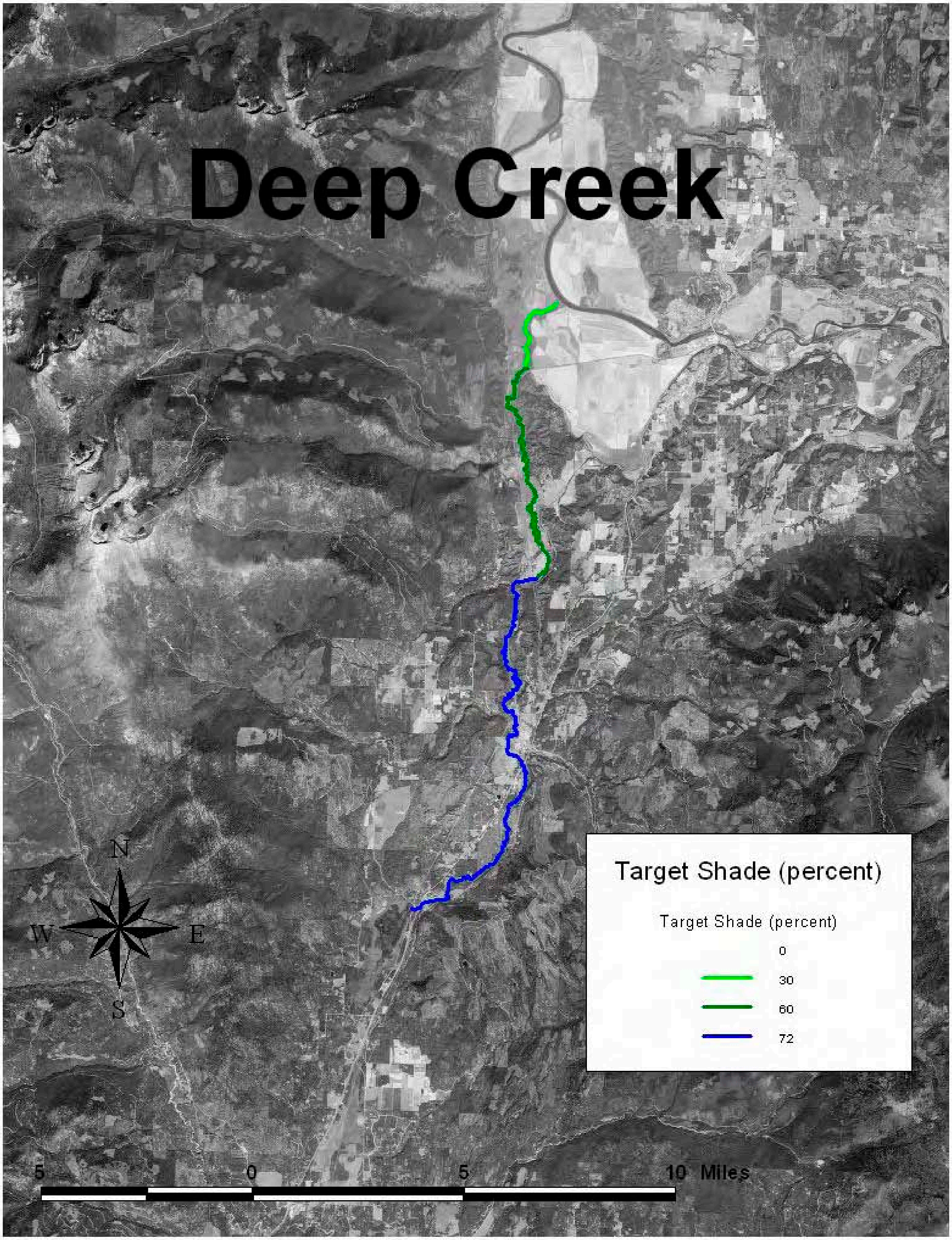

Figure 25. Target Shade for Deep Creek.

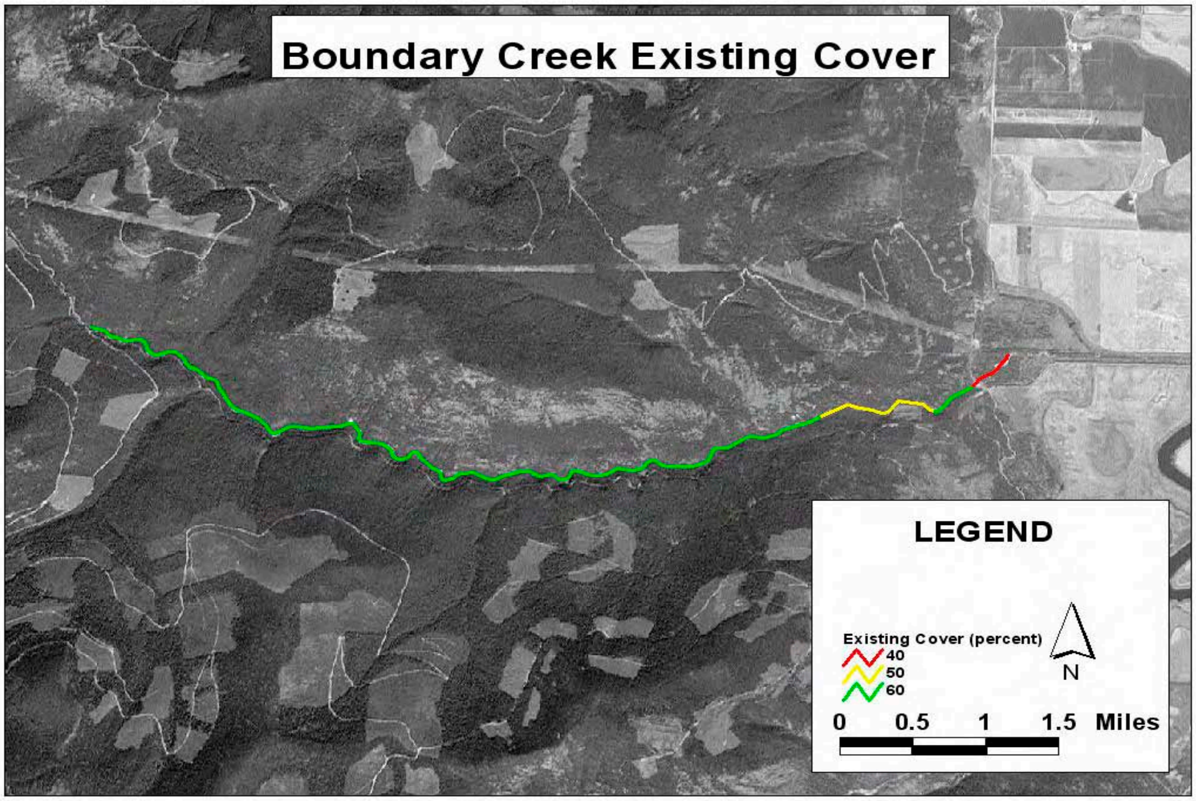

Figure 26. Existing Shade for Boundary Creek Estimated by Aerial Photo Interpretation.

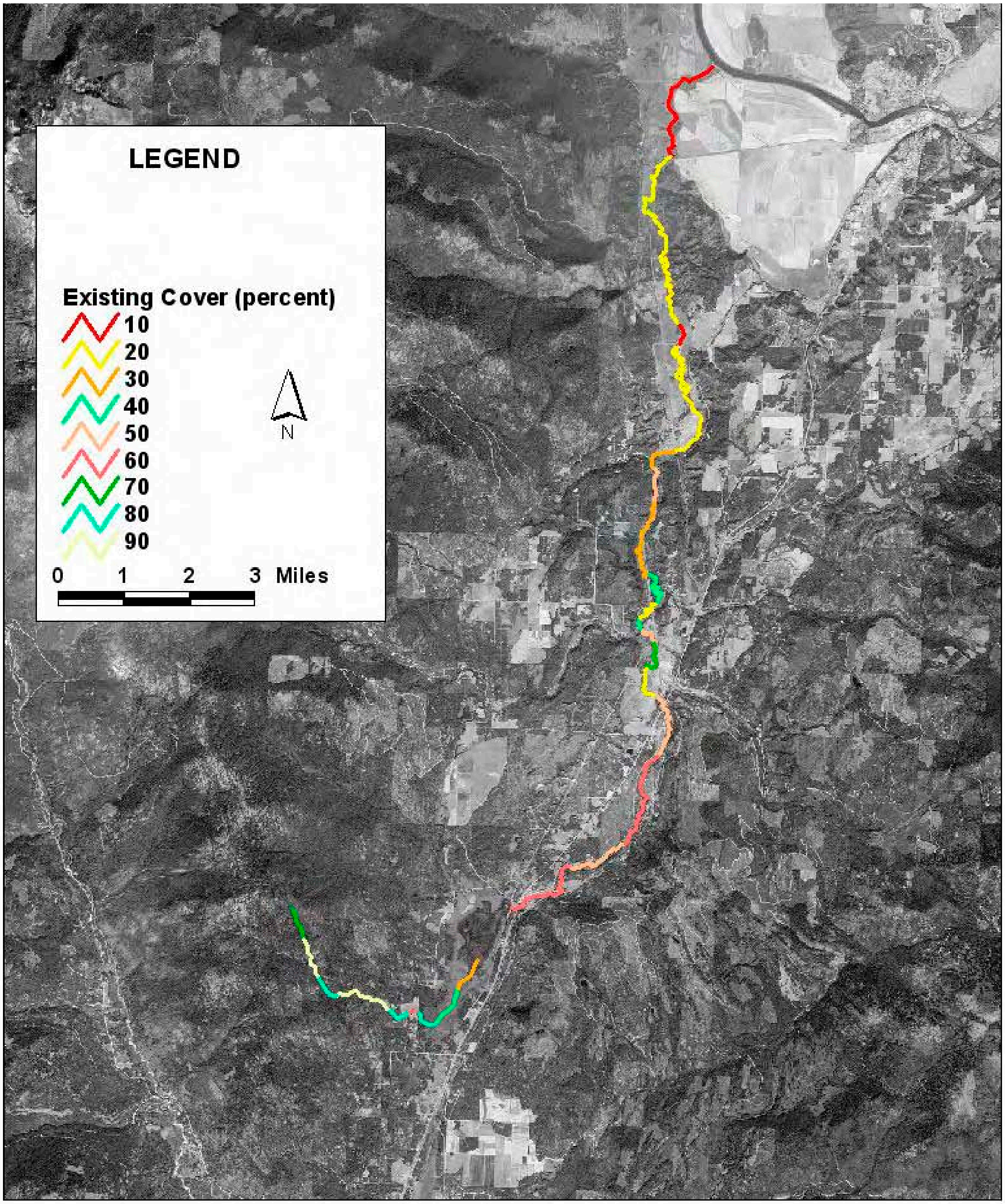

Figure 27. Existing Shade for Deep Creek Estimated by Aerial Photo Interpretation.

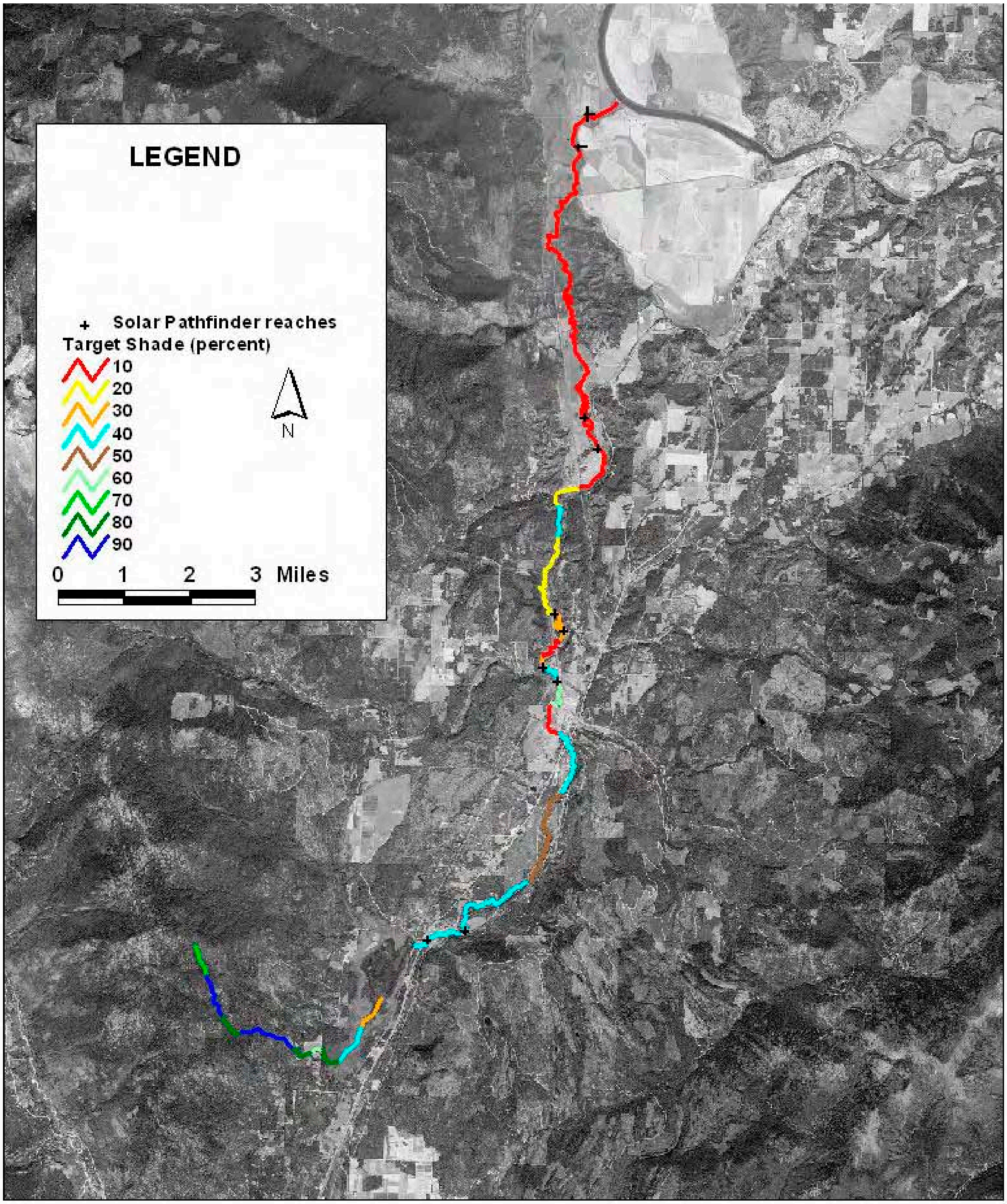

Figure 28. Existing Shade for Deep Creek Measured With Solar Pathfinder.

5.4. Load Allocation

Load allocations are discussed separately for the sediment TMDL and the temperature TMDL.

5.4.1. Sediment TMDL Load Allocation

The pollutant allocation is the load capacity minus the margin of safety and the background. A pollutant allocation is comprised of the WLA of point sources and the load allocation of nonpoint sources. Since there are no point sources, this sediment TMDL has a load allocation only.

The load allocations and reductions are shown in Table 20 for Cow Creek and Table 21 for Deep Creek. The allocations are based on the modeled estimate of nonpoint source sediment contribution of 713 tons per year (Cow Creek), 6,122 tons per year (Deep Creek) and a reduction to 50% above background. The allocation includes the background sediment yield of 405 and 3,491 tons per year, respectively, and the margin of safety is applied at the point of compliance. The load reduction required for each land ownership type is based on the difference between the existing sediment contribution and the load capacity at 50% above background. After implementation, 30 years have been allotted for meeting load allocations. This time frame will permit two or three large channel forming events to occur in the stream.

Table 20. Sediment load allocations and load reductions required for land owners along Cow Creek.

Owner/Manager	Load allocation (tons/year)	Load reduction required (tons/year)	Time frame for meeting allocations
U.S. Forest Service	688	100	30 years
Private	2	negligible	-
State	23	4	30 years
Total	713	104	-

Table 21. Sediment load allocations and load reductions required for land owners along Deep Creek.

Owner/Manager	Load allocation (tons/year)	Load reduction required (tons/year)	Time frame for meeting allocations
Bureau of Land Management	42	4	30 years
U.S. Forest Service	1,741	209	30 years
Private	3,219	534	30 years
State of Idaho	1,051	126	30 years
State of Idaho Fish and Game	53	9	30 years
National Wildlife Refuge	16	3	30 years
Total	6,122	885	-

5.4.1.1. Detailed Breakdowns of Sediment Load Allocations

A list of the sediment yield coefficients used is given first, then load allocations for Cow Creek and Deep Creek are discussed. Following that, there is a discussion about developing sediment load allocations from disturbed landscape.

5.4.1.1.1. Sediment yield coefficients used in the Kootenai River Subbasin sediment TMDL.

Bench Agriculture 0.055 (t/a/y)
Valley Agriculture 0.026 (t/a/y)
Forest (natural background) 0.03 (t/a/y)
0.03 (t/a/y) is an average of Meta sediment and Granitic geologies
Meta sediment geology 0.023 (t/a/y)
Granitic geology 0.036 (t/a/y)
Forest Road 0.50 (t/a/y)
Average of CWE scores form within the basin.
Railroad 0.50 (t/a/y)
Pipeline 25 (t/a/y)
Developed from data supplied by Gas Transmission Northwest
Disturbed 0.07 (t/a/y)
Access road associated with disturbed landscape 2 (t/a/y)
Developed from Boundary County stream bank erosion survey data.
Burn/Shrub 0.08 (t/a/y)

5.4.1.1.2. Cow Creek load allocations and details

The following tables first give the load allocations assigned by land use type for Cow Creek. Allocations are then applied according to land managers and owners based on land use.

Table 22. Cow Creek load allocation as assigned by land use type.

Land use	Total Acres in Watershed (values obtained from GIS coverage)	Current sediment generation (t/y) (total land use acres x sediment coefficient)	Load contribution by land use (current sediment generation by land use/(current sediment generation total-acres at background coefficient)	Reduction required for land use (t/y) (total reduction required x load contribution by land use)
Acres at Background Coefficient	7,408	222	na*	na*
Forest road	10	5	1%	1
Disturbed	1	negligible	negligible	negligible
Burn	6,069	486	99%	103
Open	40	0	0	0
Total	*13,528*	*713*	*100%*	*104*

*Development reduction allocation not applicable due to modeling difficulties. See section X.

Table 23. Land use within privately owned lands in Cow Creek watershed.

Land use	Acres	Land use load contribution	Current sediment generation (t/y)	Reduction (t/y)
Acres at Background Coefficient	78	na*	2	na*
Disturbed	1	negligible	negligible	negligible
Total	79	0.6%	2	negligible

*Reductions not allocated to acres at background coefficient.

Table 24. Land use within Idaho Department of Lands managed lands in Cow Creek watershed.

Land use	Acres	Land use load contribution	Current sediment generation (t/y)	Reduction (t/y)
Acres at Background Coefficient	162	na*	5	na*
Burn	221	4%	18	4
Total	383	3%	23	4

*Reductions not allocated to acres at background coefficient.

Table 25. Land use within United States Forest Service managed lands in Cow Creek watershed.

Land use	Acres	Land use load contribution	Current sediment generation (t/y)	Reduction (t/y)
Acres at Background Coefficient	7,168	na*	215	na*
Forest Road	10	100%	5	1
Burn	5,848	96%	468	99
Open	40	na	0	na
Total	13,066	96.4%	688	100

*Reductions not allocated to acres at background coefficient.

The following tables identify current loads from nonpoint government managed sources and from nonpoint privately managed sources in the Cow Creek watershed.

Table 26. Current loads from nonpoint Federal and State government managed sources in the Cow Creek watershed.

Land use	Load Reduction (t/y)	Land use load contribution
Acres at Background Coefficient	na*	na*
Forest Road	1	100%
Burn	103	100%
Total	104	na

*Reductions not allocated to acres at background coefficient.

Table 27. Current loads from nonpoint privately owned sources in the Cow Creek watershed.

Land use	Load Reduction (t/y)	Land use load contribution
Acres at Background Coefficient	na*	na*
Low Density Development	negligible	negligible
Total	negligible	negligible

*Reductions not allocated to acres at background coefficient.

5.4.1.1.3. Deep Creek load allocations and details

The following tables first give the load allocations assigned by land use type for Deep Creek. Allocations are then applied according to land managers and owners based on land use.

Table 28. Deep Creek load allocation as assigned by land use type.

Land use type	Total Watershed Acres (acres) (values obtained from GIS coverage)	Current sediment generation (t/y) (area x sediment coefficient)	Load contribution by land use (current sediment generation by land use/(current sediment generation total-acres at background coefficient)	Reduction required for land use (t/y) (total reduction required x load contribution by land use)
Bench Agriculture	7,105	391	13%	115
Valley Agriculture*	3,026	na*	na*	na*
Acres at Background Coefficient	105,145	3,154	na**	na**
Forest road	245	122	4%	35
Disturbed	756	95	3%	27
Railroad	41	20	1%	9
Pipeline	4	98	3%	27
Stream bank erosion	59	2,242	76%***	672
Open	379	0	0	0
Total	*116,760*	*6,122*	*100%*	*885*

*Valley agriculture coefficient modeled to be lower than natural background coefficient. Use of dikes in valley agriculture areas restricts sediment delivery to surface water.
**Reductions not allocated to acres at background coefficient.
*** Stream bank erosion distributed throughout watershed. Each landowner shares portion of load equal to portion of land owned within Deep Creek watershed.

Table 29. Land use within BLM administered lands in Deep Creek watershed.

Land use	Acres	Land use load contribution	Current sediment generation (t/y)	Reduction (t/y)
Acres at Background Coefficient	946	na*	28	na*
Stream bank erosion	na**	0.6%	14	4
Total	946	0.8%	42	4

*Reductions not allocated to acres at background coefficient.
** Stream bank erosion distributed throughout watershed. Each landowner shares portion of load equal to portion of land owned within Deep Creek watershed.

Table 30. Land use within NWR administered lands in Deep Creek watershed.

Land use	Acres	Land use load contribution	Current sediment generation (t/y)	Reduction (t/y)
Valley Agriculture	328	na*	na*	na*
Acres at Background Coefficient	242	na**	7	na**
Forest road	1	negligible	negligible	negligible
Railroad	1	1.3%	negligible	negligible
Stream bank erosion	na***	0.4%	9	3
Open	18	na	0	na
Total	590	0.4%	16	3

*Valley agriculture coefficient modeled to be lower than natural background coefficient. Use of dikes in valley agriculture areas restricts sediment delivery to surface water.
**Reductions not allocated to acres at background coefficient.
*** Stream bank erosion distributed throughout watershed. Each landowner shares portion of load equal to portion of land owned within Deep Creek watershed.

Table 31. Land use within privately owned lands in Deep Creek watershed.

Land use	Acres	Land use load contribution	Current sediment generation (t/y)	Reduction (t/y)
Bench Agriculture	6,967	98%	383	113
Valley Agriculture	2,627	na*	na*	na*
Acres at Background Coefficient	47,538	na**	1,426	na**
Forest road	161	65.7%	80	23
Disturbed	756	100%	95	27
Railroad	36	87.8%	18	8
Pipeline	4	100%	94	27
Stream bank erosion	na***	50%	1,123	336
Open	9	na	0	na
Total	58,098	49.8%	3,219	534

*Valley agriculture coefficient modeled to be lower than natural background coefficient. Use of dikes in valley agriculture areas restricts sediment delivery to surface water.
**Reductions not allocated to acres at background coefficient.
*** Stream bank erosion distributed throughout watershed. Each landowner shares portion of load equal to portion of land owned within Deep Creek watershed.

Table 32. Land use within Idaho Department of Lands administered lands in Deep Creek watershed.

Land use	Acres	Land use load contribution	Current sediment generation (t/y)	Reduction (t/y)
Bench Agriculture	14	0.2%	1	negligible
Valley Agriculture	72	na*	na*	na*
Acres at Background Coefficient	20,814	na**	625	na**
Forest road	37	15%	19	5
Railroad	4	10.6%	2	1
Stream bank erosion	na***	18%	404	120
Total	20,941	18%	1,051	126

*Valley agriculture coefficient modeled to be lower than natural background coefficient. Use of dikes in valley agriculture areas restricts sediment delivery to surface water.
**Reductions not allocated to acres at background coefficient.
*** Stream bank erosion distributed throughout watershed. Each landowner shares portion of load equal to portion of land owned within Deep Creek watershed.

Table 33. Land use within Idaho Department of Fish and Game administered lands in Deep Creek watershed.

Land use	Acres	Land use load contribution	Current sediment generation (t/y)	Reduction (t/y)
Bench Agriculture	112	1.6%	6	2
Forest road	3	1%	1	negligible
Acres at Background Coefficient	802	na*	24	na*
Railroad	<1	0.3%	negligible	negligible
Stream bank erosion	na**	1%	22	7
Open	329	na	0	na
Total	1,249	1%	53	9

*Reductions not allocated to acres at background coefficient.
** Stream bank erosion distributed throughout watershed. Each landowner shares portion of load equal to portion of land owned within Deep Creek watershed.

Table 34. Land use within United States Forest Service administered lands in Deep Creek watershed.

Land use	Acres	Land use load contribution	Current sediment generation (t/y)	Reduction (t/y)
Bench Agriculture	12	0.2%	1	negligible
Acres at Background Coefficient	34,803	na*	1,044	na*
Forest road	44	17.9%	22	7
Stream bank erosion	na**	30%	674	202
Open	23	na	0	na
Total	34,882	30%	1,741	209

*Reductions not allocated to acres at background coefficient.
** Stream bank erosion distributed throughout watershed. Each landowner shares portion of load equal to portion of land owned within Deep Creek watershed.

The following tables identify current loads from nonpoint government managed sources and from nonpoint privately managed sources in the Deep Creek watershed.

Table 35. Current sediment loads from nonpoint Federal and State government managed sources in the Deep Creek watershed.

Land use	Load Reduction (t/y)	Land use load contribution
Bench Agriculture	2	2%
Valley Agriculture	na*	na*
Acres at Background Coefficient	na**	na**
Forest Road	12	34.3%
Railroad	1	12.2%
Stream bank erosion	336	50%
Total	351	na

*Valley agriculture coefficient modeled to be lower than natural background coefficient. Use of dikes in valley agriculture areas restricts sediment delivery to surface water.
**Reductions not allocated to acres at background coefficient.

Table 36. Current sediment loads from nonpoint privately owned sources in the Deep Creek watershed.

Land use	Load Reduction (t/y)	Land use load contribution
Bench Agriculture	113	98%
Valley Agriculture	na*	na*
Acres at Background Coefficient	na**	na**
Forest Road	23	65.7%
Railroad	8	87.8%
Disturbed	27	100%
Pipeline	27	100%
Stream bank erosion	336	50%
Total	534	na

*Valley agriculture coefficient modeled to be lower than natural background coefficient. Use of dikes in valley agriculture areas restricts sediment delivery to surface water.
**Reductions not allocated to acres at background coefficient.

5.4.1.2. Developing Sediment Load Allocations From Disturbed Landscape

5.4.1.2.1. Discussion

Uncertainties were evident in the initial processes used to determine the spatial extent of rural development in the Kootenai River Subbasin sediment TMDL. In order to address these issues and reach the target load capacity set in the TMDL, a disconnect from the sediment model was needed.

Sediment yield allocated to high and low density development was modeled to be contributing approximately 50% of the total modeled sediment generation. Previously high and low density development sediment reductions were not allocated to land managers because of modeling limitations. Not requiring land managers to reduce the modeled sediment generation from high and low density development would result in failure to meet the target load capacity set in the TMDL.

Sediment contribution from high and low density development to surface waters is noted as occurring within the basin. However, the modeled amount of sediment yield to surface water is uncertain. Estimates of sediment contribution have the potential of ranging from thousands of pounds per year to hundreds of pounds per year. The problem is known to exist but limited information reduces the precision to which an estimation can be made.

The initial high and low density development strategy discussed in the previous section does not appear appropriate for load allocations. Approximately half of the load generated in the watershed was constructed from acreages and loading coefficients that had been estimated and did not result from scientifically derived data or processes. While the initial estimates seemed to be reasonable when separate, the compounding of the estimates resulted in less than reasonable results.

The sediment modeling process discussed above was applied to BURP sites in the Lower Kootenai River Subbasin. Land use types were modeled within the basin to determine an appropriate target. A target of 50% above background was established using this method. In the initial model, high and low density development land use type was applied throughout the basin to achieve the target. This process identified streams which exhibit failing WBAG II scores and modeled high sediment yields.

To reach reasonable results a second step was taken to allocate sediment generated from high and low density development, now called disturbed landscape. The disturbed land use type was developed from known structures within the Deep Creek watershed. Based on professional experience within the watershed, each structure was assumed to disturb one acre of land and occupy a 20-acre lot. Using a road width of 20 feet and length of 640 feet, the average access road is 0.03 acres in size. A sediment yield coefficient of 0.07 t/a/y was applied to the one acre disturbed by a structure and 2 t/a/y was applied to the access road. The sediment yield of 0.07 t/a/y was derived from best professional judgment and an estimate which assumes a structure disturbance would generate slightly more than twice background sediment. A poorly maintained forest road within the basin would typically generate 2 t/a/y. The estimated road sediment generation was derived from field observations, data collected in the basin and professional experience.

A disturbed landscape is defined in the model as the land associated with known structures within the basin. This process of allocating a sediment load to rural and urban areas is an attempt to capture all known land use types within the basin. Future attempts to model a disturbed landscape should not be done until a better understanding of sediment yield from such landscapes is understood. Additional information should be a priority within the basin to refine sediment coefficients in order to determine the most appropriate sediment load allocation.

5.4.1.2.2. Conclusion

Attempts to model sediment yield to surface water are intended to provide relative, rather than exact, sediment yields. The Lower Kootenai and Moyie River Subbasins sediment model attempts to model all land use types observed in the watershed separately. Attempting to model different sediment sources observed in the watershed is intended to identify the primary sources of sediment. Identifying sediment sources will be useful when developing implementation strategies designed to retard sediment delivery to surface water.

Data gaps exist in the Lower Kootenai and Moyie River Subbasins sediment model and are not expected to be filled in the near future. Future sediment modeling of disturbed landscape in the basin may consider adjusting the neighborhood area or adjusting the sediment yield coefficient accordingly. These adjustments to the model may better represent sediment yield to surface water and achievable load allocations. Modeling of sediment yield to surface waters of the basin is intended to highlight areas of the basin which are main sediment contributors.

5.4.2. Temperature TMDL Load Allocation

Because this TMDL is based on potential natural vegetation, which is equivalent to background loading, the load allocation is essentially the desire to achieve background conditions. However, in order to reach that objective, load allocations are assigned to nonpoint source activities that have affected or may affect riparian vegetation and shade. Load allocations are therefore specific to each stream reach and are dependent upon the target load for a given reach.

and 1 show the target or potential shade which is converted to a potential summer load by multiplying the inverse fraction (1 minus the shade fraction) by the average loading to a flat plate collector for the months of April through September. That is the loading capacity of the stream and it is necessary to achieve background conditions. There is no opportunity to allocate shade removal to an activity.

Generally, existing solar loads exceed potential solar loads on Deep Creek, and to a lesser extent on Boundary Creek, because existing shade is less than potential shade. Deep Creek's existing solar load is 2,027,916 kWh/day and its target load should be 1,133,354 kW/day. The difference (-894,562 kWh/day) shows that loads on Deep Creek need to decrease by about 44% to achieve background conditions. Boundary Creek's potential summer load should be about 600,000 kWh/day to maintain temperatures at background conditions. Existing summer load exceeds that value by 28,500 kWh/day, requiring about 4.5% reduction in load to achieve background conditions.

In addition to not having load allocations for nonpoint source activities, there are also no point sources in the affected watersheds. Thus, there are no wasteload allocations. Should a point source be proposed that would have thermal consequence on these waters, then background provisions addressing such discharges in Idaho water quality standards (IDAPA 58.01.02.200.09 & IDAPA 58.01.02.401.03) should be involved (see Appendix B).

5.4.3. Margin of Safety

5.4.3.1. Sediment TMDL Margin of Safety

The margin of safety is implicit in the model used. Loading capacities set at 50% above background have been used in previous TMDLs and considered sufficiently conservative. This level of conservative assumptions provides an over-estimation of sediment yield. The over-estimation is the implicit margin of safety. Given the conservatively high estimations developed by the model, no additional explicit margin of safety is deemed necessary. An implicit margin of safety of 231% for Belt Supergroup geologies and 164% for Kaniksu Granitics was averaged and applied in the sediment model.

5.4.3.2. Temperature TMDL Margin of Safety

The margin of safety in this TMDL is considered implicit in the design. Because the target is essentially background conditions, there are no loads allocated to sources or activities. Although the loading analysis used in this TMDL involves gross estimations that are likely to have large variances, there are no load allocations that may benefit or suffer from that variance.

5.4.4. Seasonal Variation

5.4.4.1. Sediment TMDL Seasonal Variation

The method used for calculation of sediment pollutant load in this TMDL does not account for seasonal variation. Instead the load is described in the units of percent above background.

5.4.4.2. Temperature TMDL Seasonal Variation

This TMDL is based on average summer loads. All loads have been calculated to be inclusive of the six month period from April through September. This time period was chosen because it represents the time period when the combination of increasing air and water temperatures coincides with increasing solar inputs and increasing vegetative shade. The critical time period is June when spring salmonids spawning is occurring, July and August when maximum temperatures exceed cold water aquatic life criteria, and September during fall salmonids spawning (see Figures C-1 through C-10 in Appendix C). Water temperature is not likely to be a problem for beneficial uses outside of this time period because of cooler weather and lower sun angle.

5.4.5. Reasonable Assurance

5.4.5.1. Sediment TMDL Reasonable Assurance

The model identified stream bank erosion within the watershed as the primary source of sediment. The federal government manages 97% of the land in the Cow Creek watershed, the State of Idaho manages 3% and less than 1% is privately owned. In the Deep Creek watershed the federal government manages 30%, the State of Idaho 18%, State of Idaho Fish and Game 1%, the Bureau of Land Management less than 1% and private individuals 50%. The large federal ownership within the subbasin should assure implementation plan development and execution. Sediment issues on private land can be addressed by incentives provided to private land owners by the Boundary Soil and Water Conservation District. The plan will be implemented based primarily on the budgetary constraints of incentive programs and federal agencies.

5.4.5.2. Temperature TMDL Reasonable Assurance

Reasonable assurance is provided by nonpoint source implementation of BMPs based on land management agencies' assurance that reductions will occur. Incentive programs offered to privately owned and managed land will also help to insure solar load reductions.

5.4.6. Background Load

5.4.6.1. Sediment TMDL Background Load

The background sediment load for the Cow Creek watershed is 405 tons per year and 3,491 tons per year for the Deep Creek watershed, as shown in

Table 14 and Table 15, respectively. The background is treated as part of the load capacity and is allocated as part of the load capacity. Any unknown unallocated point sources would be included in the background portion of the allocation.

5.4.6.2. Temperature TMDL Background Load

The background temperatures and thermal inputs to Deep and Boundary Creek are unknown. It is assumed that when stream shading reaches PNV targets that background temperatures and thermal inputs will be achieved.

5.4.7. Load Reserve

5.4.7.1. Sediment TMDL Load Reserve

No part of the load allocation is held for additional load. All new infrastructures should be constructed or mitigated to allow no net increase in sediment yield to the Deep and Cow Creek watersheds.

5.4.7.2. Temperature TMDL Load Reserve

Reserve is typically removed from a WLA for installations that might be made in the future. No WLA or reserve is developed for the temperature TMDL. The thermal capacity of the watershed has been exceeded by canopy removal. Canopy restoration to the degree possible is required to address the thermal loading. Point sources of thermal input cannot be permitted for the foreseeable future.

5.4.8. Construction Storm Water and TMDL Wasteload Allocations

5.4.8.1. Construction Storm Water

The Clean Water Act requires operators of construction sites to obtain permit coverage to discharge storm water to a water body or to a municipal storm sewer. In Idaho, EPA has issued a general permit for storm water discharges from construction sites. In the past storm water was treated as a nonpoint source of pollutants. However, because storm water can be managed on site through management practices or when discharged through a discrete conveyance such as a storm sewer, it now requires a National Pollution Discharge Elimination System (NPDES) Permit.

5.4.8.2. The Construction General Permit (CGP)

If a construction project disturbs more than one acre of land (or is part of larger common development that will disturb more than one acre), the operator is required to apply for permit coverage from EPA after developing a site-specific Storm Water Pollution Prevention Plan.

5.4.8.3. Storm Water Pollution Prevention Plan (SWPPP)

In order to obtain the Construction General Permit operators must develop a site-specific Storm Water Pollution Prevention Plan. The operator must document the erosion, sediment, and pollution controls they intend to use, inspect the controls periodically and maintain the best management practices (BMPs) through the life of the project.

5.4.8.4. Construction Storm Water Requirements

When a stream is on Idaho's § 303(d) list and has a TMDL developed DEQ now incorporates a gross wasteload allocation (WLA) for anticipated construction storm water activities. TMDLs developed in the past that did not have a WLA for construction storm water activities will also be considered in compliance with provisions of the TMDL if they obtain a CGP under the NPDES program and implement the appropriate Best Management Practices.

Typically there are specific requirements you must follow to be consistent with any local pollutant allocations. Many communities throughout Idaho are currently developing rules for post-construction storm water management. Sediment is usually the main pollutant of concern in storm water from construction sites. The application of specific best management practices from *Idaho's Catalog of Storm Water Best Management Practices for Idaho Cities and Counties* is generally sufficient to meet the standards and requirements of the General Construction Permit, unless local ordinances have more stringent and site specific standards that are applicable.

5.5. Implementation Strategies

DEQ and designated management agencies (DMA) responsible for TMDL implementation will make every effort to address past, present, and future pollution problems in an attempt to link them to watershed characteristics and management practices designed to improve water quality and restore the beneficial uses of the water body. Any and all solutions to help restore beneficial uses of a stream will be considered as part of a TMDL implementation plan in an effort to make the process as effective and cost efficient as possible. Using additional information collected during the implementation phase of the TMDL, DEQ and the designated management agencies will continue to evaluate suspect sources of impairment and develop management actions appropriate to deal with these issues.

DEQ recognizes that implementation strategies for TMDLs may need to be modified if monitoring shows that the TMDL goals are not being met or significant progress is not being made toward achieving the goals.

5.5.1. Time Frame

For sediment TMDLs, 30 years has been allotted for meeting load allocations. This time frame will permit two or three large channel forming events to occur in the stream.

A reasonable time frame should be allotted for meeting target shade levels in the Boundary and Deep Creek watersheds. A substantial time frame may be needed to reach PNV after implementation strategies have been installed.

5.5.2. Approach

TMDLs will be implemented through continuation of ongoing pollution control activities in the subbasin. The designated WAG, DMAs and other appropriate public process participants, are expected to:

- Develop best management practices (BMPs) to achieve load allocations.
- Give reasonable assurance that management measures will meet load allocations through both quantitative and qualitative analyses of management measures.
- Adhere to measurable milestones for progress.
- Develop a timeline for implementation, with reference to costs and funding.
- Develop a monitoring plan to determine if BMPs are being implemented, if individual BMPs are effective, if load allocations and waste load allocations are being met and whether or not water quality standards are being met.

The designated management agencies will recommend specific control actions and will then submit the implementation plan to DEQ. DEQ will act as a repository for approved implementation plans and conduct 5-year reviews of progress toward TMDL goals.

5.5.3. Responsible Parties

In addition to the designated management agencies, the public, through the WAG and other equivalent process or organizations, will be provided with opportunities to be involved in developing the implementation plan to the maximum extent practical.

5.5.4. Monitoring Strategy

Monitoring will be conducted using the DEQ-approved monitoring procedure at the time of sampling.

5.6. Conclusions

5.6.1. Sediment TMDL Conclusions

The assessment of the Lower Kootenai River Subbasin indicates that WBAG II scores and sediment modeling reveal sediment impairment of the cold water use in Cow Creek and Deep Creek. A sediment TMDL has been prepared for Cow Creek and Deep Creek. The TMDL sets a goal of 50% above natural background sediment yield based on sediment yield from watersheds of the subbasin fully supporting the cold water beneficial use. A load capacity was set based on this goal. An implicit margin of safety of 231% for Belt Supergroup geologies and 164% for Kaniksu Granitics was averaged and applied in the sediment model. No point sources of sediment exist or are expected. Sediment load allocations were allocated to land managers and owners based on the amount of land managed or owned and modeled land use types within the watershed.

The remaining available load is allocated among the nonpoint sources (load allocation), since no point sources of sediment exist or are expected to exist in the watersheds.

5.6.2. Temperature TMDL Conclusions

Target shade levels for Boundary and Deep Creek were determined from effective shade curves from other northwest TMDLs with similar vegetation characteristics and stream widths. Existing shade levels were estimated from aerial photos and field verified with a solar pathfinder.

Existing shade levels on Boundary Creek are only slightly less than target shade levels. Calculations indicate a 4.5% reduction in solar loading is needed to achieve natural background levels. However, this level of reduction is probably within the variability of the estimation techniques used to generate loads. Boundary Creek is likely at its potential in terms of shading and solar loading. It is not known what conditions exist in Canada upstream on Boundary Creek. Temperatures vary about 2 ^{o}C from the upper end of Boundary Creek to the lower end in Idaho (Figures C-2 and C-3), a 1,600-foot change in elevation. It is likely that this temperature difference is the result of elevation changes in air temperature.

Because existing shade is less than potential shade solar loads exceed potential solar loads on Deep Creek. Existing shade levels within Deep Creek were modeled to be 44% above background conditions. Calculations indicate a 44% reduction in solar loading is needed to achieve natural background levels.

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